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Altruistic behavior as a costly signal of general intelligence

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Abstract

Unconditional altruism is an enduring puzzle for evolutionary approaches to social behavior. In this paper we argue that costly signaling theory, a well-established framework in biology and economics, may be useful to shed light on the individual differences in human unconditional altruism. Based on costly signaling theory, we propose and show that unconditional altruistic behavior is related to general intelligence. The cost incurred by engaging in unconditional altruism is lower for highly intelligent people than for less intelligent people because they may expect to regain the drained resources. As a result, unconditional altruism can serve as an honest signal of intelligence. Our findings imply that distinguishing altruistic behavior from cooperative behavior in social psychological and economic theories of human behavior might be useful, and that costly signaling theory may provide novel insights on various individual difference variables.

Keywords: costly signaling, altruism, cooperation, general intelligence

Introduction

Altruistic behavior is difficult to reconcile with a Darwinian perspective. A behavior that reduces an individual's fitness cannot survive the selective forces of natural selection. Indeed, as altruism appears to reduce an individual's fitness, natural selection seems to predispose individuals to selfishness (Williams, 1992). Individuals need resources to survive and reproduce, therefore finite resources imply competition. Incurring a cost to help another organism does not seem to fit in the strict Darwinian framework. Many theories explaining various types of cooperation have been proposed in biology and economics (Fehr & Fischbacher, 2003; Gurven, 2004) but *unconditional* altruism (defined as benefiting others at a cost to oneself, Wilson, 1976) has remained elusive to date.

The purpose of the present investigation was to provide a first step towards establishing the potential of costly signaling theory for increasing our understanding of altruistic behavior. In essence, we propose that altruistic behavior may serve as a costly signal of general intelligence. Before describing the specific studies, it may be helpful to review costly signaling theory. Costly signaling theory (CST; Grafen, 1990a&b; Zahavi, 1975, 1997) explains how individuals use costly behaviors to convey information about themselves. People may differ in the qualities that they possess, such as economic status or certain skills. These qualities are partially concealed, although others may be interested in this information, for instance in the process of selecting partners. These partners prefer an actor possessing a certain quality to an actor not possessing it. As a result, actors possessing an unobservable but desirable quality have an incentive to signal their quality to perceivers because perceivers are more likely to select them as a partner if they know their true type. However, actors *not* possessing the quality have an incentive to mimic the signal. Costly signaling theory provides a framework that explains how signals can be transmitted in a reliable way. Signal reliability is secured by making the signal costly and the signal-cost quality-dependent (Zahavi & Zahavi, 1997). Quality-dependence of the cost reflects the characteristic that the cost is smaller for individuals possessing the quality than for agents lacking it. Only those possessing the quality can afford the quality-dependent cost that the signal entails. As a consequence of the quality-dependent cost structure, the perceiver of the signal can be confident that the signaling actor has the underlying quality. For example: the purchase of a very expensive (i.e. the cost) piece of art provides the reliable information that the buyer effectively is very wealthy (i.e. the quality). After all, someone lacking a huge amount of resources is simply not able to waste money on this kind of luxury products.

Costly signaling theory and altruism

The statement that altruism may serve as a costly signal has received theoretical support in anthropology, biology, and economics (e.g. Boone, 1998; Gintis, Smith & Bowles, 2001; Lotem, Fishman & Stone, 2000; Roberts, 1998; Gurven, 2004). Empirical support for the theory is beginning to emerge. Anthropological fieldwork (in a Meriam community, living on islands off the northeast tip of Australia) investigated the typical profile of men who provided turtles for a feast, which is considered as an altruistic act because it is costly for the providers (Bliege Bird, Smith & Bird, 2001). The research showed that success at hunting (and hence the ability to provide the feast) depends on several qualities of the hunter such as e.g. his environmental knowledge, strength, leadership skills, and organizational skills. As the amount of food that a hunter can provide is reliably related to these skills, altruism may serve as a costly signal of those underlying abilities (Bliege Bird et al., 2001; Smith & Bliege Bird, 2000). Experimental work showed that participants may compete by means of altruism to signal trustworthiness (Barclay, 2004).

Altruistic behavior is costly by definition. However, it is less clear what quality altruistic behavior might be related to. Although unequivocal evidence for the link is still missing, some authors mentioned the possibility that altruism is related to intelligence and others reported data that seem consistent with our claim. We now turn to a brief review of that literature.

As mentioned above, Bliege Bird et al. (2001) found that some men of the Meriam spend their time turtle-hunting, which requires specific valued skills of the hunter. As hunting turtles is a relatively costly way of collecting food, it may serve as a costly signal of underlying qualities. Bliege Bird et al. (2001) proposed that problem solving ability as one underlying quality that is needed to be successful at hunting: Hunters with higher cognitive skills should be more successful at capturing turtles as they know better where they can find turtles, how exactly to catch them, etc. Providing turtles for a feast (an altruistic act) may serve as a signal for this underlying quality as the lower quality hunters are expected to fail more often on a hunt than high-quality individuals and as a consequence would not have the same success in providing turtles. Accordingly, unpublished data by Dewitte and De Cremer (2005) showed that students who had contributed much to group assignments had higher grades than those who contributed their fair share or less than their share. Furthermore, Van Vugt, Roberts and Hardy (forthcoming) recently suggested that altruism might signal intelligence as it may take brainpower to appreciate the long-term benefits of cooperation.

In addition, Glazer and Konrad (1996) provided evidence that alumni's sponsoring of their former college qualifies as a costly signal of wealth. As children's intelligence predicts later socio-economic success better than parents' attributes (Gottfredson, 1994), Glazer and Konrad's finding is consistent with our claim that altruism and IQ are related. We assume that intelligent people are better able to acquire resources. As a consequence, donating part of these resources is relatively less costly for highly intelligent people even before these resources are acquired. Our claim that altruism is a costly signal of the underlying quality intelligence allows us to predict a relationship between intelligence and altruism.

Study 1

We hypothesize that someone who is acting altruistically is more intelligent than someone acting cooperatively or egoistically. However, in typical public good games altruism and cooperation are indistinguishable. Either players can choose from only two options (cooperation or not), or giving more than the appropriate amount (i.e. altruistic act) does not make much sense. Millet and Dewitte (2006) slightly adapted the public good game in such a way that cooperative and altruistic behavior can be differentiated. We adopt the same methodology in this study.

Method

One hundred seventy-six undergraduates at a large European University (60 women and 113 men) aged between 18 and 27 year participated. The monetary reward depended on their performance (minimum of 5 euro).

We organized a repeated public good game with four players, similar to the procedure by Millet and Dewitte (2006). Decisions were made simultaneously and involved contributing a certain amount to the provision of a public good. At the beginning of each round, all participants received an endowment of 40 points. In each round, they had to decide how much of the endowment they would invest in the public good or keep for themselves. Every point was worth 3.39 eurocent. All the points that were invested, were subtracted from their 40 points endowment. If the good was obtained (100 points, i.e. the provision point), 160 points were distributed equally across the four players in that round, irrespective of individual contributions.

Upon arrival, each participant was assigned to a computer in a partially enclosed carrel. Participants neither saw nor talked to each other. They believed that they played a game involving six people, but in reality they played against the computer. Participants were told that four of the six participants were players in the game, and that two others were observers of the game. The observers did not play themselves. They were told that the roles of player and observer could change during the game. All participants started, allegedly by random selection, as an observer. They twice observed that the good was not obtained. The shortage was 5 (out of 100) points in the first round and 2 points (out of 100) in the second. They did not receive information about individual contribution levels. After the first two rounds, participants replaced one person in the game and decided how much they invested in the public good. As the group had twice failed to reach the public good, the third round was a very uncertain situation in which the outcome was highly unpredictable. We distinguished three behavioral categories, defined in relation to the fair contribution level of 25 points, i.e. the provision point divided by the number of players. Participants could contribute either exactly (i.e. cooperative decision), less (i.e. egoistic decision), or more than the fair share (i.e. altruistic decision). We measured participants' decisions (cooperative, egoistic or altruistic) in the first round that they played (i.e. the third round of the game). The game ended after the third round.

Measures of General Intelligence.

Appromixately 20 minutes after the game, participants received a computerized short-version of Raven Advanced Progressive Matrices IQ - test (RPM) (adapted from Verguts and De Boeck, 2002). They had to solve as many problems as possible in 15 minutes. A recent review showed that the RPM-test is one of the best measures of general intelligence (Gray & Thompson, 2004). We predict a higher score on this test for the altruists than for the others.

Additionally, participants were assessed on a simple (SRT) and four-choice (CRT) reaction time task before the game. The procedure was similar to that used by Deary, Der and Ford (2001), except for the fact that our task was administered on computer. In SRT, digits were presented with varying interstimulus intervals (1-3 s) and participants had to press an assigned key as fast as possible. In CRT, one of four possible digits was presented with varying interstimulus intervals (1-3 s). Each digit was linked to one key. Participants had to press the corresponding key as fast as possible when a digit was presented. Each digit appeared 10 times in randomized order. Eight practice trials were presented before the actual reaction time task. There were 20 trials for the SRT and 40 for the CRT task. Means and standard deviations were obtained for both tasks, based on correct responses only. Because CRT is more strongly related to intelligence than SRT in the high range of the IQ continuum (Der & Deary, 2003), we predicted the relation of altruism with CRT to be stronger than with SRT (as our sample consists of university students).

Results and discussion

Four participants were not considered for analysis because they did not comply with instructions. Of the remaining 169 participants 68 acted egoistically (42 men, 26 women), 59 cooperatively (41 men, 18 women) and 42 altruistically (26 men, 16 women). A two (Sex) by three (Public Goods Choice) factorial Anova revealed that RPM score (M = 30.46, SD = 7.22) was significantly affected by a main effect of Public Goods Choice (F (2, 163) = 3.27, p < .05, η^2 = .04). Altruists ($M_{altruistic}$ = 33.07, $SD_{altruistic}$ = 6.80) scored higher on the RPM than egoists ($M_{egoistic}$ = 29.84, $SD_{egoistic}$ = 7.08; p < .07) and cooperators ($M_{cooperative}$ = 29.32, $SD_{cooperative}$ = 7.33, p < .02) (see Figure 1). There was no difference between egoists and cooperators (p = .38).[1] The analogous analysis showed a significant effect of Public Goods Choice on CRT (M = 524.03, SD = 74.38; F (2, 163) = 3.26, p < .05, η^2 = .04). Altruists ($M_{altruistic}$ = 499.74, $SD_{altruistic}$ = 79.10) reacted faster than egoists ($M_{egoistic}$ = 525.14, $SD_{egoistic}$ = 63.11; p < .04) and cooperators ($M_{cooperative}$ = 540.03, $SD_{cooperative}$ = 79.45; p < .02) (see Figure 2). There was no difference between egoists and cooperators (p = .62). Sex did not have any effect. No other significant effects emerged (all p's > .10). For SRT, no effect emerged (F (2, 163) = 0.66, p = .517; see Figure 3). This study shows that those people opting to behave altruistically in the public good game were more intelligent, as measured by two well-established but relatively independent measures of general intelligence (relation between both: r = -.14, p = .07). The fact that the simple reaction time was not faster among altruists, rules out the possibility that altruists were just more motivated to help the experimenter.

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[1] Consistent with Abad, Colom, Rebollo, and Escorial (2004) we found that men scored significantly higher than women (F (1, 163) = 7.54, p < .01), presumably because of the test's visuo-spatial nature. No other significant effects emerged (p's > .10).

Study 2

To rule out the concern that the altruistic choice in the public good situation may partially result from self-interested motives, we conducted a follow-up study to investigate the link between a genuine pro-social motivation and general intelligence as measured by the RPM. We adapted Van Lange, Otten, De Bruin, and Joireman's (1997) Social Value Orientation measure and added a fourth option to each choice situation that reflected the altruistic option. That option maximizes joint outcome rather than own outcome (see also Eek and Gärling, 2005).

Method

One hundred twenty-five undergraduates at a large European University (80 women and 45 men) aged between 17 and 28 year participated in exchange for a participation fee. Standard instructions were given that valuable points had to be distributed between oneself and an other person. One had to imagine that the other person was someone they had never met and that they would never meet again. Afterwards participants got nine different choice situations (see Appendix). These situations were similar to the following one:

	A	B	C	D
You get	500	500	550	500
The other gets	100	500	300	550

Alternatives A, B and C are identical to the options in the items of the original Social Value Orientation measure of Van Lange et al. (1997). Option *A* maximizes the difference between oneself and the other (maxdif); option *B* minimizes the difference between oneself and the other (mindif) and option *C* maximizes the own outcome with disregard for the other's outcome (maxown). We added option *D*, where the joint outcome is maximized at the cost of inequality in the advantage of the other (maxjoint). This last option is similar to the one adopted by Eek and Gärling (2005). Our extended version was preprogrammed on computer and for each choice situation (9 in total) we asked participants to rank order the attractiveness of the four alternatives (1 = most attractive; 4 = least attractive option). Afterwards we summed the nine ranks for each of the four social motives and reversed the scores for clarity, so that high scores mean high levels of the motive. In that way we obtained values for 4 different variables that we called maxjoint (cfr. D), mindiff (cfr. B), maxown (cfr. C), maxdif (cfr. A).

Results and discussion

Scores on the maxjoint variable were separated into three groups based on the lower (below percentile 33.3), middle and upper (above percentile 66.6) thirds of the distribution. Two participants were not considered for analysis because they did not comply with instructions. In line with literature, we focused only on the ‘high’ and ‘low’ maxjoint group and left out the middle group for analysis (see e.g. Giesler et al., 1996). Therefore, 78 participants remained for statistical analysis. In line with our hypothesis, we found that the RPM score (M = 29.62, SD = 5.58) was higher for the high than for the low maxjoint group (M_{high} = 30.90, SD_{high} = 5.43; M_{low} = 28.36, SD_{low} = 5.57; F (1, 74) = 4.34, p < .05, η^2 = .06). There was no effect of gender nor of the interaction between gender and maxjoint group (all p’s > .10). In a similar manner we distinguished between a high and low group on the maxown, mindif and maxdif variables. Raven IQ-scores did not differ between the high and low groups for the maxown and mindif variables (all F’s < 1). However, we found that the average raven-IQ score was marginally higher for the low than for the high maxdif group (M_{high} = 28.28, SD_{high} = 5.82; M_{low} = 29.93, SD_{low} = 4.55; F (1, 79) = 5.23, p < .08, η^2 = .04).

In this study, we found evidence for a positive relationship between intelligence and a genuine pro-social motivation, namely maximizing the joint outcome even at the cost of inequality in the advantage of the other. This motivation is very similar to the altruistic behavior in study 1 because in that situation, giving more than the fair share implies giving more than most others, and hence ending up with less than the others. We found no relation between intelligence and the traditional normative pro-social motivation, namely minimizing differences between contributors (Van Lange et al., 1999). We also found no relation between intelligence and the individualistic orientation (maxown), which is inconsistent with the explanation of the results of study 1 in terms of self-interest. Instead, we found a slight *negative* relationship between intelligence and self-interested motivations that maximize the relative advantage at the cost of the joint outcome.

Discussion

The results of studies 1 and 2 indicate a consistent pattern of findings. We find support for a positive relationship between intelligence and altruistic behavior. In the first study, we found that those who contributed more than their fair share to a public good were more intelligent, as measured by two relatively independent measures of general intelligence. In the second study, we showed that those who possess a dispositional tendency to value joint benefits more than their own, scored higher on an intelligence test.

The evidence presented supports the possibility that unconditional altruism may serve as a costly signal of general intelligence because altruism is costly and is reliably linked to the quality ‘general intelligence’. Consistent with the finding that children’s intelligence predicts later socio-economic success better than parents’ attributes (Gottfredson, 1994), we assume that intelligence is an indicator of future resources. As a consequence, someone with high cognitive skills may be able to donate more in advance than someone with lower skills. As such, the cost of altruistic behavior could be quality-dependent. This finding and the theoretical approach we provide opens up various avenues for future research.

A first opportunity for future research lies in the further exploration of the role of altruism in mate selection. Pro-social behavior in men appears to be a desirable trait for women (Jensen-Campbell, Graziano, & West 1995). Intelligence also seems to be one of the most important criteria for both genders in choosing partners (Li, Bailey, Kenrick & Linenmeier, 2002). Future research may look at whether altruism is a desirable mate characteristic for its own sake (e.g. predicting care), whether it is attractive because it signals intelligence, or both.

Our theoretical approach focused on the ultimate cause of the relation between general intelligence and altruistic behavior. Specifically, we claimed that altruism functions as a costly signal of general intelligence. A second opportunity for future research therefore lies in the investigation of the proximate cause of the link between general intelligence and altruism. Our second study already suggests that general intelligence is related to a genuine pro-social motivation. These motives may trigger emotional reactions to an opportunity to act altruistically, such as empathy or feelings of responsibility which may lead to the altruistic act itself. It is also possible that high levels of intelligence allows people to take a broader perspective on their decisions (Vallacher and Wegner, 1987). This may help them go beyond the pursuit of immediate gratification, which often coincides with egoistic behavior (Dewitte & De Cremer, 2001).

The search for proximate causes also points at the possible role of intervening variables. A third opportunity for future research is the search for third variables that have been shown to be related to both intelligence and altruism. Leadership is a possible candidate. Van Vugt (in press) reviewed evidence showing that generosity and leadership are related and that leaders' social skills are better developed than those of followers. Moreover, Bass (1990) reviewed evidence that intelligence and leadership are positively related. Combined with these insights, our data point at an interesting possibility: general intelligence may explain part of the relation between leadership and generous behaviors.

The possibility that intelligence may explain the relation between leadership and generosity opens up a fourth avenue for future research. We submit the hypothesis that altruism may be a costly signal of general underlying fitness, including not only intelligence but also leadership status and health. Remarkably, leadership and health are associated: leaders's health is better than that of followers (Van Vugt, forthcoming). In addition, Brown et al. (2003) found that providing support to the spouse, friends, relatives and neighbors predicted mortality in a sample of married elderly: those giving support had lower mortality risk (controlled for current health and degree of support received). Although the authors concluded that providing support to others benefits health, their data are also consistent with the costly signaling framework: providing support may be a costly signal of fitness. Several recent lines of research indeed support the suggestion that intelligence may be closely linked to general fitness. First, a link between general intelligence and longevity was shown by Deary and Der (2005). This link was found for two diverse measures of intelligence: A reaction times task and a classical psychometric intelligence test, and did not depend on social class, education, or smoking status. Second, Prokosch et al. (2005) recently showed that body symmetry - a general fitness indicator – is also positively related to scores on a Raven Progressive Matrices Test. In their vision, general intelligence and body symmetry tap into and underlying “fitness factor” and this underlying fitness indicator may explain the relation between intelligence and longevity among others. So, the findings of Prokosch et al. (2005) may suggest a positive relationship between general fitness indicators (different from general intelligence) and altruism. In that way, altruistic behavior may serve as a general fitness indicator and not only as indicator for general intelligence.

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References

Abad, F.J., Colom, R., Rebollo, I., & Escorial, S. (2004). Sex differential item functioning in the Raven's Advanced Progressive Matrices: evidence for bias. *Personality and individual differences, 36*, 1459-1470.

Barclay, P. (2004). Trustworthiness and competitive altruism can also solve the "tragedy of the commons". *Evolution and Human Behavior 25* 209-220.

Bliege Bird, R., Smith, E.A., & Bird, D.W. (2001). The hunting handicap: costly signaling in male foraging strategies. *Behavioral Ecology and Sociobiology, 50*, 9-19.

Boone, J.L. (1998). The Evolution of Magnanimity: When Is It Better To Give Than To Receive? *Human Nature 9*(1): 1-21.

Der, G., & Deary, I.J. (2003). Iq, reaction time and the differentiation hypothesis. *Intelligence*, 31, 491-503.

Deary, I. J., & Der, G. (2005). Reaction time explains association with death. *Psychological Science, 16*, 64-69.

Deary, I. J., Der, G., & Ford, G. (2001). Reaction times and intelligence differences. A population-based cohort study. *Intelligence, 29*, 389-399.

Dewitte, S., & De Cremer D. (2005). Experimental evidence for altruism as costly signaling. Working paper at Katholieke Universiteit Leuven.

Dewitte, S., & De Cremer, D. (2001). Self-control and cooperation: different concepts, similar processes? A question of the right perspective. *The Journal of Psychology, 135*, 133-153.

Eek, D., & Gärling, T. (in press). Prosocials prefer equal outcomes to maximizing joint outcome. *British Journal of Social psychology*.

Fehr, E., & Fischbacher, U. (2003). The nature of human altruism. *Nature, 425*, 785-791.

Fehr, E., & Schmidt, K.M. (1999). A theory of fairness, competition, and cooperation. *Quarterly Journal of Economics, 114*, 817-868.

Giesler, R.B., Josephs, R.A., & Swann, W.B.Jr. (1996). Self-verification in clinical depression: the desire for negative evaluation. *Journal of Abnormal Psychology, 105*, 358-368.

Gintis, H., Smith, E.A., & Bowles, S. (2001). Costly signaling and cooperation. *Journal of Theoretical Biology, 213*, 103-119.

Glazer, A., & Konrad, K.A. (1996). A signaling explanation for charity. *The American Economic Review, 86*, 1019-1028.

Gottfredson, L.S. (2004). Intelligence: Is it the epidemiologists' elusive "fundamental cause" of social class inequalities in health? *Journal of Personality and Social Psychology, 86*, 174-199.

Grafen (1990). Sexual selection unhandicapped by the fischer process. *Journal of Theoretical Biology, 144*, 473-516.

Grafen (1990). Biological signals as handicaps. *Journal of Theoretical Biology, 144*, 517-546.

Gray, J. R., & Thompson, P. M. (2004). Neurobiology of intelligence: science and ethics. *Nature Reviews Neuroscience, 5*, 471-482.

Gurven, M. (2004). To give and to give not: the behavioral ecology of human food transfers. *Behavioral and Brain Sciences, 27*, 543-583.

Hardin, G. (1968). The tragedy of the commons. *Science, 162*, 1243-1248.

Jensen-Campbell, L. A., Graziano, W. G., & West, S. G. (1995). Dominance, prosocial orientation, and female preferences: do nice guys really finish last? *Journal of Personality and Social Psychology, 68*, 427-440.

Li, N. P., Bailey, J. M., Kenrick, D. T., & Linsenmeier, J. A. W. (2002). The necessities and luxuries of mate preferences: testing the tradeoffs. *Journal of Personality and Social Psychology, 82*, 947-955.

Lotem, A., Fishman, M. A., Stone, L. (2003). From reciprocity to unconditional altruism through signalling benefits. *Proceedings of the Royal Society of London Series B-Biological Sciences, 270*, 199-205.

Millet, K., & Dewitte, S. (2006). Second to fourth digit ratio and cooperative behavior. *Biological Psychology, 71 (1)*, 111-115.

Prokosch, M.D., Yeo, R.A., & Miller, G.F. (2005). Intelligence tests with higher g-loadings show higher correlations with body symmetry: Evidence for a general fitness factor mediated by developmental stability. *Intelligence, 33*, 203-213.

Roberts, G. (1998). Competitive altruism: from reciprocity to the handicap principle. *Proceedings of the Royal Society of London Series B-Biological Sciences, 265*, 427-431.

Smith, E. A., & Bliege Bird, R. (2000). Turtle hunting and tombstone opening: public generosity as costly signaling. *Evolution and Human Behavior, 21*, 245-261.

Trivers, R. L. (1971). The evolution of reciprocal altruism. *Quarterly Review of Biology, 46*, 35-57.

Vallacher, R.R., & Wegner, D.M. (1987). What do people think they're doing? Action identification and human behavior. *Psychological Review, 94*, 3-15.

Van Lange, P. A. M., Otten, W., De Bruin, E. M. N., & Joireman, J. A. (1999). Development of prosocial, individualistic, and competitive orientations: Theory and preliminary evidence. *Journal of Personality and Social Psychology, 73*, 733-746.

Van Vugt, M. (forthcoming). Evolutionary origins of leadership and followership. *Personality and Social Psychology Review*.

Van Vugt, M., Roberts, G., & Hardy, C. (forthcoming). Competitive Altruism: Development of reputation-based Cooperation in Groups. In Dunbar, R. & Barrett, L., *Handbook of Evolutonary Psychology.* Oxford: University Press.

Verguts, T., & De Boeck, P. (2002). The induction of solution rules in Raven's Progressive Matrices. *European Journal of Cognitive Psychology, 14*, 521-547.

Williams, G.C. (1992). *Natural selection: domains, levels, and challenges*. New York: Oxford University Press.

Wilson, E. O. (1976). *Sociobiology: a new synthesis.* Harvard University Press.

Zahavi (1975). Mate selection - A selection for a handicap. *Journal of Theoretical Biology, 53*, 205-214.

Zahavi, A., & Zahavi, A. (1997). *The handicap principle: a missing piece of Darwin's puzzle*. New York: Oxford University Press.

Figure 1. RPM-score as a function of public goods choice.

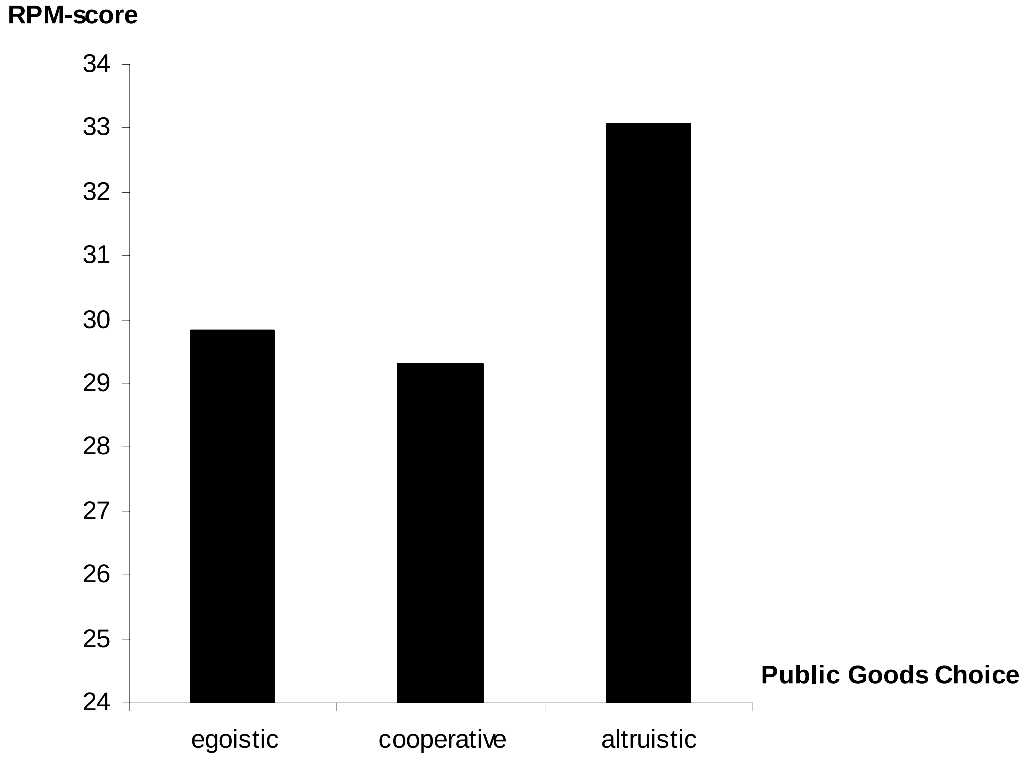


Figure 2. Choice Reaction Time as a function of public goods choice.

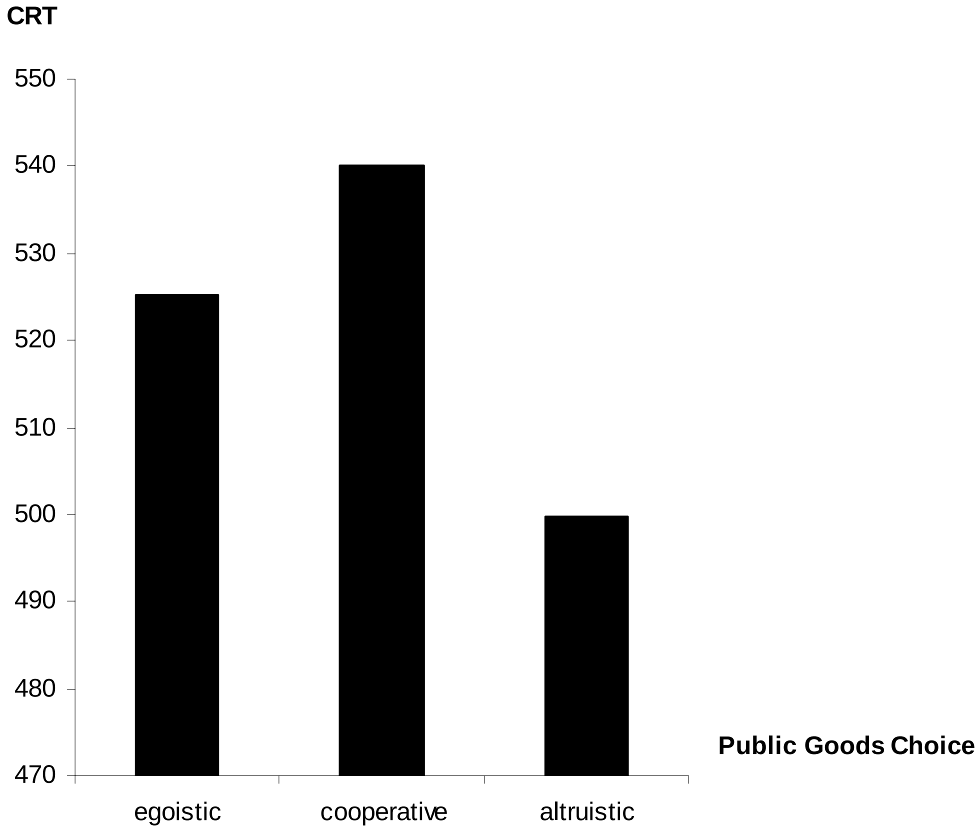
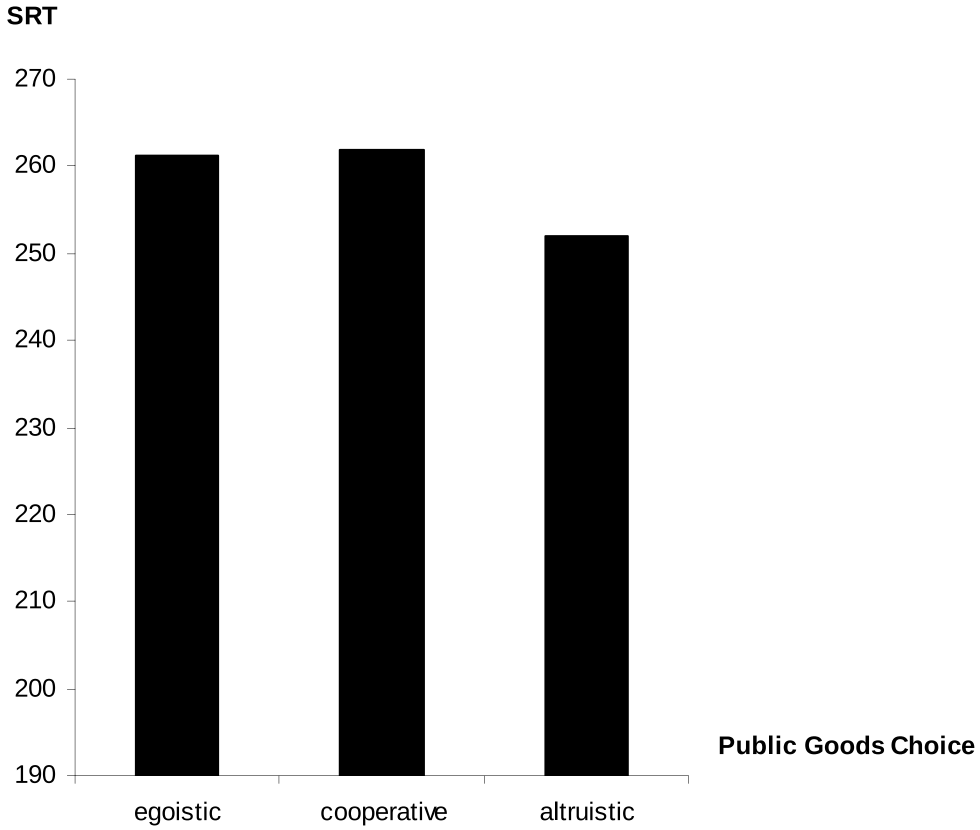


Figure 3. Simple Reaction Time as a function of public goods choice.



Appendix

		A	B	C	D
(1)	You	480	540	480	480
	Other	80	280	480	540

		A	B	C	D
(2)	You	560	500	500	500
	Other	300	500	560	100

		A	B	C	D
(3)	You	520	520	520	580
	Other	520	580	120	320

		A	B	C	D
(4)	You	490	500	560	490
	Other	560	100	300	490

		A	B	C	D
(5)	You	490	560	500	500
	Other	90	300	500	560

		A	B	C	D
(6)	You	570	500	500	500
	Other	300	500	570	100

		A	B	C	D
(7)	You	510	510	510	560
	Other	510	560	110	300

		A	B	C	D
(8)	You	500	500	550	500
	Other	550	100	300	500

		A	B	C	D
(9)	You	480	540	490	490
	Other	100	300	490	540